

## IMAGE READING APPARATUS

### BACKGROUND OF THE INVENTION

#### Field of the Invention

5 This invention relates to an image reading apparatus.

#### Description of Related Art

The construction of a conventional image reading apparatus will hereinafter be described with 10 reference to Figs. 12 to 14 of the accompanying drawings.

In Fig. 12, the reference numeral 1201 designates an image reading apparatus (hereinafter referred to as the image scanner) for reading an 15 image, and the reference numeral 1202 denotes an auto document feeder (hereinafter referred to as the ADF) for automatically successively feeding a plurality of originals one by one.

The reference numeral 1203 in the image scanner 20 1201 designates copy board glass, and an original 1204 is placed on the copy board glass 1203 and a desired image is read. The procedure of reading the image will hereinafter be described briefly.

The reference numeral 1205 denotes a light 25 source for applying light to the original, and generally when the read image is to be outputted in black and white, a yellow green light source is used,

and when the read image is to be outputted in colors,  
a white light source is used. As the kinds of the  
light source, various kinds of light sources such as  
a cold cathode tube, a halogen lamp and a xenon lamp  
5 are used depending on the uses thereof.

Reflected light 1206 applied from the light  
source 1205 to the original is reflected by a first  
mirror 1207, a second mirror 1208 and a third mirror  
1209, is condensed by a lens unit 1210 and is imaged  
10 on a CCD 1211 which is a photoelectric conversion  
element.

The light information of the imaged light is  
converted into a voltage by the CCD 1211, is further  
converted from an analog signal to a digital signal,  
15 and thereafter is subjected to a series of correcting  
processes such as shading correction, black level  
correction and gamma correction, and is outputted to  
a monitor, a file or the like.

The constituents from the light source 1205 to  
20 the CCD 1211 are constituted as a carriage unit 1212  
by a unit. A reading optical system thus containing  
the constituents of the optical system in a carriage  
unit, if dimensional accuracy in the carriage unit  
1212 is controlled, has the merit that the quality of  
25 the read image is not spoiled even if other  
dimensional accuracy is not finely controlled.

Also, the reference numeral 1213 designates a

white reference plate constructed at a location which cannot be seen from an original placing surface, and upon closing of a power source switch or at the timing immediately before image reading, the light  
5 source 1205 is turned on and the white reference plate 1213 is read to thereby detect the offset gain adjustment of an A/D converter (not shown) for converting the analog voltage photoelectrically converted by the CCD 1211 into a digital voltage, and  
10 the trouble of the light source 1205.

As the popular construction of another reading optical system, there is a 1 to 1/2 optical system shown in Fig. 13. This reading optical system is of a construction in which a first optical unit 1301  
15 including a light source 1205 and a first mirror 1207, and a second optical unit 1302 including a second mirror 1208 and a third mirror 1209 are movable units, and a lens unit 1210 and a CCD 1211 are fixed. Since the moving speeds of the first optical unit 1301 and  
20 the second optical unit 1302 are designed to be 1:1/2, this reading optical system is called the 1 to 1/2 optical system. By being designed at such a speed ratio, the distance from a reading position to the CCD is always constant at  $a+L_1+L_2+b$ . This reading  
25 optical system has a merit in depth of focus because the distance between an object and an image can be secured long, while on the other hand it becomes

necessary to sufficiently control the dimensional accuracy of the entire scanner.

The carriage unit 1212 or the first optical unit 1301 and the second optical unit 1302 are one-dimensional reading units which can read an image of a predetermined width ( $84.7 \mu\text{m}$  at 300dpi). A one-dimensional image read thereby can be read as the two-dimensional image of the entire original by connecting together images one-dimensionally read while the carriage unit 1212, the first optical unit 1301 and the second optical unit 1302 are moved by a motor (not shown). After the image of the entire original has been read, it is outputted to a personal computer or a monitor or the like.

As described above, an original like a photograph which cannot be bent, a thick original such as a book, or an original to be read with a high quality of image usually has its image read while being placed on the copy board glass. On the other hand, for the reading of a plurality of original sheets, there has been carried out a method of collectively reading images by the use of the ADF 1202. It should be noted that in some cases, the carriage unit 1212 is constituted by a CIS module.

The reference numeral 1214 denotes an ADF open detection sensor for detecting whether the ADF 1202 is opened or not.

The detailed construction of the ADF 1202 will now be described with reference to the construction view of Fig. 14.

The reference numeral 1401 designates an original tray for stacking originals 1402 thereon, and the originals 1402 are stacked on the original tray 1401 with images to be read facing upward. The reference numeral 1403 denotes a sheet presence or absence detection sensor for detecting the presence or absence of the originals 1402 on the original tray 1401, and it is designed to use a photointerrupter and a mechanical flag to detect the state thereof. When the start of reading is executed with the originals 1402 stacked on the original tray 1401, a conveying roller 1404 is driven for only one full rotation by a solenoid, and only one of the originals is conveyed into the conveying path of the ADF 1202. The thus conveyed original 1402 is formed into a predetermined loop by a registration roller 1405, and the leading edge of the original 1402 conveyed into the ADF 1202 is detected by a leading edge detection sensor 1406. The reference numeral 1407 designates a photointerrupter which is an original leading edge detection sensor, and it is linked with the leading edge detection sensor 1406 by a mechanical flag, and design is made such that the leading edge of the original 1402 pushes out the mechanical flag, whereby

the photointerrupter 1407 is shielded from light. The original 1402 is further conveyed into the interior of the ADF 1202 along the circumference of an original roller 1409 while being nipped between a 5 first conveying roller 1408 and the original roller 1409 and between a supporting unit 1410 and the original roller 1409, and the reading of the image of the original 1302 is started at the timing whereat the original 1402 arrives at Mylar 1411. This timing 10 is judged in a predetermined time after the leading edge detection sensor 1406 has detected the leading edge of the original, or if a stepping motor is used as the motor, by predetermined pulses having elapsed after the leading edge sensor 1406 has detected the 15 leading edge of the original.

The original 1402 of which the image has been read from the leading edge is delivered onto a discharging tray 1413 by a second conveying roller 1412, and the reading of the first original is 20 terminated.

The second and subsequent originals are fed in a predetermined time after the leading edge detection sensor 1406 has detected the leading edge of the original 1402, or if a stepping motor is used as a 25 drive source for conveying sheets, a solenoid is driven at such timing that they are fed after the lapse of predetermined pulses, and the above-

described control is continued until the sheet presence or absence detection sensor 1403 comes to detect no original on the original tray 1401.

Also, if there is no change in the result of  
5 detection even when a predetermined time has elapsed after the leading edge detection sensor 1406 has detected the leading edge of the original 1402, control is effected so that it may be treated as jam.

10 SUMMARY OF THE INVENTION

In the above-described conventional example, a reading mode conforming to the moving speed of the carriage is primarily determined, and users' broad needs could not be coped with completely. For  
15 example, among the users there are two kinds of users, i.e., users who want to give priority to resolution, and users who want to give priority to gradation, and reading modes desired by respective users could not be provided by a single product. An object of the  
20 present invention is to solve such a problem of the conventional example.

Another object of the present invention is to provide an image reading apparatus having:

a light source for applying light to an image;  
25 moving means for moving a unit including at least the light source;  
photoelectric converting means for converting

the reflected light of the light source applied to an original into a voltage;

analog-digital converting means for converting an analog signal outputted from the photoelectric  
5 converting means into a digital signal; and

a driving signal generating part for supplying a driving signal to the photoelectric converting means and the analog-digital converting means;

wherein the moving speed of the moving means is  
10 not changed, but there are held a plurality of kinds of signal patterns supplied by the driving signal generating part.

A further object of the present invention also provides an image reading apparatus having:

15 a light source for applying light to an image; moving means for moving a unit including at least the light source;

photoelectric converting means for converting the reflected light of the light source applied to an  
20 original into a voltage;

analog-digital converting means for converting an analog signal outputted from the photoelectric converting means into a digital signal; and

25 a plurality of amplifying means for amplifying a signal outputted from the analog-digital converting means;

wherein switch means is provided in the power

source supplying part of predetermined one of the amplifying means, and a switch is ON/OFF-controlled in conformity with a reading mode.

Other objects, constructions and effects of the  
5 present invention will become apparent from the following detailed description and the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

10 Fig. 1 shows the construction of an image reading apparatus for illustrating a first embodiment.

Fig. 2 is an electrical block diagram of the image reading apparatus for illustrating the first embodiment.

15 Fig. 3 is an electrical block diagram of a scanner control part for illustrating the first embodiment.

Fig. 4 is an electrical block diagram of the peripheral part of a CCD for illustrating the first  
20 embodiment.

Fig. 5 is a timing chart of a gradation priority mode for illustrating the first embodiment.

Fig. 6 is a timing chart of the gradation priority mode for illustrating the first embodiment.

25 Fig. 7 shows the construction of an image reading apparatus for illustrating a second embodiment.

Fig. 8 is an electrical block diagram of the image reading apparatus for illustrating the second embodiment.

5 Fig. 9 is an electrical block diagram of a scanner control part for illustrating the second embodiment.

Fig. 10 is an electrical block diagram of the surrounding parts of a CCD for illustrating the second embodiment.

10 Fig. 11 is an electrical block diagram of an ADC output part for illustrating the second embodiment.

Fig. 12 shows the construction of an integral optical system in an image reading apparatus for 15 illustrating the conventional type of the apparatus.

Fig. 13 shows the construction of a 1 to 1/2 optical system in the image reading apparatus for illustrating the conventional type of the apparatus.

20 Fig. 14 shows the construction of an ADF in the image reading apparatus for illustrating the conventional type of the apparatus.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

##### (First Embodiment)

25 A first embodiment of the present invention will hereinafter be described with reference to Figs. 1 to 4. In this embodiment, the same constituents as

those in the example of the prior art are given the same reference numerals.

In Fig. 1, the reference numeral 1201 designates an image scanner for reading an image, and 5 the reference numeral 1202 denotes an ADF for automatically successively conveying a plurality of originals one by one.

The reference numeral 1203 in the image scanner designates copy board glass, and an original 1204 is 10 placed on the copy board glass 1203 and a desired image is read. The procedure of reading the image will hereinafter be described briefly.

The reference numeral 1205 denotes a light source for applying light to the original, and 15 generally when the read image is to be outputted in black and white, a yellow green light source is used, and when the read image is to be outputted in colors, a white light source is used. As the kinds of the light source, various kinds of light sources such as 20 a cold cathode tube, a halogen lamp and a xenon lamp are used depending on the uses thereof.

Reflected light 1206 applied from the light source 1205 to the original 1204 is reflected by a first mirror 1207, a second mirror 1208 and a third 25 mirror 1209, is condensed by a lens unit 1210 and is imaged on a CCD 1211 which is a photoelectric conversion element. The optical information of the

imaged light is converted into a voltage by the CCD 1211, is further converted from an analog signal into a digital signal, and is subjected to a series of correcting processes such as shading correction, 5 black level correction and gamma correction.

The one-dimensional information of the original 1204 read in this manner is sequentially read while a carriage unit 1212 is moved in the sub-scanning direction of the original by a motor (not shown), 10 whereby it is connected together as two-dimensional information, and the entire original is read.

Fig. 2 is an electrical block diagram of the image scanner described with reference to Fig. 1. In Fig. 2, the reference numeral 201 designates a 15 scanner control part which governs the control of an image reading system, and the reference numeral 202 denotes an image control part which governs various kinds of correction control such as shading correction and gamma correction, communication control with an external output apparatus such as a personal computer, and the control of an operation part 203 for a user to effect various kinds of setting, on the basis of an image signal transmitted from the scanner control part 201. Fig. 3 is a finer 20 block diagram of the scanner control part 201, and in Fig. 3, the reference numeral 1201 designates the image scanner, the reference numeral 1202 denotes the

ADF, and by what elements each of these is constituted is shown. The reference numeral 301 designates a CPU which governs the control of the entire electrical system of the image scanner 1201,

5 and the CPU 301 has connected thereto an inverter 302 for boosting a DC voltage to control the turning-on the light source 1205 for applying light to the original 1204, and further converting the DC voltage into an AC voltage, a driver 304 for a motor 303 for

10 moving a unit including the light source 1205 to thereby move the position of the light applied to the original 1204, a home position sensor 305 for detecting the reference position of the unit including the light source 1205, a driving signal

15 generating part 307 for outputting a driving signal to the CCD 1211 for converting the reflected light applied from the light source 1205 to the original into a voltage and an A/D converter 306 for converting an analog voltage outputted from the CCD

20 1211 into a digital signal, an opening and closing detection sensor 1214 for detecting the opening and closing of the ADF 1202, and a driver 309 for the conveying motor 308 of the ADF 1202. In the ADF 1202, there are mounted an original detection sensor 310

25 for detecting the presence or absence of the original, the conveying motor 308, a solenoid 311 which provides a clutch for feeding originals one by one,

and a leading edge detection sensor 312 for detecting the leading edge of the fed original, and these electrical parts in the ADF 1202 are also connected to and controlled by the CPU 301 in the image scanner 1201. Further, the CPU 301 introduces thereinto the image signal outputted from and converted into a voltage by the A/D converter 306, and transmits the image signal to the image control part 202 in synchronism with various kinds of timing signals.

10 Fig. 4 is a block diagram for illustrating the constructions of the CCD 1211, the A/D converter 306 and the driving signal generating part 307 in greater detail.

The CPU 301 effects serial communication with 15 the driving signal generating part 307, and the setting of a reading mode selected by the user is transmitted from the CPU 301 to the driving signal generating part 307, which in turn transmits a driving signal conforming to the reading mode to the 20 CCD 1211 and the A/D converter 306. Also, the driving signal generating part 307 stores black level/white level data transmitted from the A/D converter 306 in a memory in the driving signal generating part 307, and transmits the data stored in 25 this memory to the CPU 301. The CPU 301 calculates the offset set in the A/D converter 306 and a gain value on the basis of the black level/white level

data transmitted from the driving signal generating part 307, and transmits them to the A/D converter 306.

The driving signal transmitted from the driving signal generating part 307 to the CCD 1211 and the 5 A/D converter 306 assumes such timing as shown in Fig. 5. CK is a reference clock supplied to the driving signal generating part 307,  $\phi_1$  and  $\phi_2$  are the charge transmitting clocks of the CCD 1211, and 1RS is the reset clock of the CCD 1211. Also, AD\_CK is the 10 driving clock of the A/D converter 306, CK1 is a clock for sampling the reference level of the signal outputted from the CCD 1211, and CK2 is a clock for sampling the signal component of the signal outputted from the CCD 1211. Driving waveforms shown here are 15 waveforms in a reading mode giving priority to resolution, and it is a feature of the present embodiment that besides this reading mode, a reading mode giving priority to gradation is set.

Fig. 6 shows driving waveforms in the reading 20 mode giving priority to gradation.

In Fig. 6, as compared with Fig. 5, it is seen that each driving waveform is a half relative to the frequency of the mode giving priority to resolution. Thus, again in the mode giving priority to gradation, 25 the speed of the motor for moving the carriage is set to the same speed as in the mode giving priority to resolution, and the frequency of the clock supplied

to the CCD and the A/D converter is set to a half in the mode giving priority to gradation relative to the mode giving priority to resolution, whereby the resolution in the sub-scanning direction in the mode giving priority to gradation becomes a half as compared with that in the mode giving priority to resolution. The resolution in the main scanning direction is uniformly determined by the resolving power of the CCD and is therefore invariable.

Accordingly, if the resolution in the mode giving priority to resolution is 600 dpi in the main scanning direction and 600 dpi also in the sub-scanning direction, the resolution in the mode giving priority to gradation will be 600 dpi in the main scanning direction and 300 dpi in the sub-scanning direction.

On the other hand, when the reading speed in the sub-scanning direction is not changed but the resolution alone is changed to a half, an accumulation time for each pixel of the CCD becomes double. The fact that the accumulation time becomes double means that theoretically S/N also becomes double, and thus gradation increases by 1 bit.

As described above, by setting a reading mode in which the speed of the carriage for reading an image is not changed but the frequency of a clock supplied from the driving signal generating part to

the CCD and the A/D converter is decreased to a half, it becomes possible to realize a reading mode giving priority to gradation. While in the present embodiment, description has been made of a case where  
5 the frequency of the clock supplied from the driving signal generating part to the CCD and the A/D converter is decreased to a half, of course a similar effect can be obtained even if the ratio of this frequency is decreased to 1/3, 1/4 or 1/2.5.

10 (Second Embodiment)

In the first embodiment, a reading mode giving priority to gradation has been realized by setting a reading mode in which the speed of the carriage for reading an image is not changed but the frequency of  
15 the clock supplied from the driving signal generating part to the CCD and the A/D converter is decreased to a half. The present embodiment is characterized in that attention is paid to a data width necessary for each of the mode giving priority to gradation and the  
20 mode giving priority to resolution, and when a driver at the rear stage of the A/D converter is unnecessary in the mode giving priority to resolution, the supply of electric power to the driver is cut off by switch means.

25 A second embodiment of the present invention will hereinafter be described with reference to Figs. 7 to 9. In this embodiment, the same constituents as

those in the example of the prior art and the first embodiment are given the same reference numerals.

In Fig. 7, the reference numeral 1201 designates an image scanner for reading an image, and 5 the reference numeral 1202 denotes an ADF for automatically successively conveying a plurality of originals one by one.

The reference numeral 1203 in the image scanner 1201 designates copy board glass, and an original 10 1204 is placed on the copy board glass 1203 and a desired image is read. The procedure of reading the image will hereinafter be described briefly.

The reference numeral 1205 denotes a light source for applying light to the original, and 15 generally when the read image is to be outputted in black and white, a yellow green light source is used, and when the read image is to be outputted in colors, a white light source is used. As the kinds of the light source, various kinds of light sources such as 20 a cold cathode tube, a halogen lamp and a xenon lamp, depending on the uses thereof.

Reflected light 1206 applied from the light source 1205 to the original 1204 is reflected by a first mirror 1207, a second mirror 1208 and a third 25 mirror 1209, is condensed by a lens unit 1210 and is imaged on a CCD 1211 which is a photoelectric conversion element. The optical information of the

imaged light is converted into a voltage by the CCD 1211, if further converted from an analog signal into a digital signal, and is subjected to a series of correcting processes such as shading correction, 5 black level correction and gamma correction. The one-dimensional information of the original 1204 read in this manner is sequentially read while a carriage unit 1212 is moved in the sub-scanning direction of the original by a motor (not shown) and is thereby 10 connected together as two-dimensional information, and the entire original is read.

Fig. 8 is an electrical block diagram of the image scanner described with reference to Fig. 7. In Fig. 8, the reference numeral 201 designates a 15 scanner control part which governs the control of an image reading system, and the reference numeral 202 denotes an image control part which governs various kinds of correction control such as shading correction and gamma correction and communication control with an external output apparatus such as a personal computer, and the control of an operation part 203 for the user to effect various kinds of setting, on the basis of an image signal transmitted from the scanner control part 1. Fig. 9 is a finer 20 block diagram of the scanner control part 201 of Fig. 8, and in Fig. 9, the reference numeral 1201 designates the image scanner, and the reference

numeral 1202 denotes the ADF, and by what elements each of these is constituted is shown. The reference numeral 301 designates a CPU which governs the control of the entire electrical system of the image  
5 scanner, and the CPU 301 has connected thereto an inverter 302 for boosting a DC voltage and further converting it into an AC voltage to control the turning-on of the light source 1205 for applying light to the original, a driver 304 for a motor 303  
10 for moving a unit including the light source 1205 to thereby move the position of the light applied to the original, a home position sensor 305 for detecting the reference position of the unit including the light source 1205, a driving signal generating part  
15 307 for outputting a driving signal to the CCD 1211 for converting the reflected light applied from the light source 1205 to the original and an A/D converter 306 for converting an analog voltage outputted from the CCD 1211 into a digital voltage,  
20 an opening and closing detection sensor 1214 for detecting the opening and closing of the ADF 1202, and a driven 309 for the conveying motor 308 of the ADF 202. Also, in the ADF 1202, there are mounted an original detection sensor 310 for detecting the  
25 presence or absence of the original, the conveying motor 308, a solenoid 311 which provides a clutch for feeding originals one by one, and a leading edge

detection sensor 312 for detecting the leading edge of the fed original, and each of these electrical parts in the ADF 1202 is also connected to and controlled by the CPU 301 in the image scanner 1201.

- 5 Further, the CPU 301 introduces thereinto an image signal outputted from the A/D converter 306 and converted into a voltage, and transmits the image signal to the image control part 202 in synchronism with various kinds of timing signals.

10 Fig. 10 is a block diagram for illustrating the constructions of the CCD 1211, the A/D converter 306 and the driving signal generating part 307 in greater detail.

The CPU 301 effects serial communication with  
15 the driving signal generating part 307, and the setting of a reading mode is transmitted from the CPU301 to the driving signal generating part 307, which in turn transmits a driving signal conforming to the reading mode to the CCD 1211 and the A/D  
20 converter 306. Also, the driving signal generating part 307 stores black level/white level data transmitted from the A/D converter 306 in a memory in the driving signal generating part 307, and effects the calculation of the average value of the optical  
25 black portion image data of the CCD 1211 and the holding of the peak value of effective pixel range data on the basis the aforementioned black

level/white level data, and transmits the result thereof to the CPU 301. The CPU 301 calculates the offset set in the A/D converter 306 and a gain value on the basis of the data transmitted from the driving 5 signal generating part 307, and transmits them to the A/D converter 306.

Fig. 11 is a block diagram showing the flow of the data of the scanner control part and the image processing part. In Fig. 11, an area encircled by 10 broken line is the scanner control part 201, and data conforming to the image signal is outputted from the A/D converter 306 mounted in the scanner control part 201, and is usually outputted in parallel as shown. The data outputted from the A/D converter 306 is once 15 inputted to drivers 1101 and 1102, and is further outputted to the image control part (not shown).

Here, when the mode giving priority to gradation handles 9-bit data, the mode giving priority to resolution handles 8-bit or less data, 20 and when the operation is going on in the mode giving priority to resolution, the driven 1102 becomes unnecessary. Therefore, switch means 1103 is provided in the power supply line of the driver to control so that during the mode giving priority to 25 gradation, the switch may be brought into ON state to thereby supply the power source of the driver, and during the mode giving priority to resolution, the

switch may be brought into OFF state to thereby cut off the power source of the driver.

As described above, the switch means is provided in the power supply line of the driver to control so that during the mode giving priority to gradation, the switch may be brought into ON state to thereby supply the power source of the driver, and during the mode giving priority to resolution, the switch may be brought into OFF state to thereby cut off the power source of the driver, whereby a consumed electric current in each reading mode can be optimally controlled.

As has hitherto been described, an aspect of the image reading apparatus is an image reading apparatus having a light source for applying light to an image, moving means for moving a unit including at least the light source, photoelectric converting means for converting the reflected light of the light source applied to an original into a voltage, analog-digital converting means for converting an analog signal outputted from the photoelectric converting means into a digital signal, and a driving signal generating part for supplying a driving signal to the photoelectric converting means and the analog-digital converting means, characterized in that the moving speed of the moving means is not changed, but there are held a plurality of kinds of signal patterns

supplied by the driving signal generating part, and a single product can cope with the needs of a user demanding the priority of resolution and a user demanding the priority of gradation.

5       Another aspect of the image reading apparatus is an image reading apparatus having a light source for applying light to an image, moving means for moving a unit including at least the light source, photoelectric converting means for converting the reflected light of the light source applied to an original into a voltage, analog-digital converting means for converting an analog signal outputted from the photoelectric converting means into a digital signal, and a plurality of amplifying means for amplifying a signal outputted from the analog-digital converting means, characterized in that switch means is provided in the power source supplying part of predetermined one of the amplifying means, and a switch is ON/OFF-controlled in conformity with a reading mode, and optimum electric power consumption conforming to image data becomes possible.

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While the present invention has been described above with respect to some preferred embodiments thereof, the present invention is not restricted to these embodiments, but it is apparent that various modifications and applications are possible within the scope of the invention as defined in the appended claims.